Part 3: More About Vaccines

How do vaccines work?

To understand how vaccines work, it helps to understand how immunity works.

Immunity

The human immune system is designed to protect us from anything that enters our body that doesn't belong there (not including food, of course). Immunologists call these things "non-self."

When a disease organism (that is, a germ – a virus or bacteria) enters the body, the immune system recognizes it as "non-self," and produces proteins called antibodies to get rid of it. These antibodies find and destroy the specific germ that is causing the infection. (For example, antibodies to polio attack polio virus and nothing else.)

But in addition, the immune system *remembers* this germ. Later on, if the person is exposed to the same germ again, antibodies are quickly deployed to eliminate it before it can make the person sick again. This is immunity.

Immunity is why a person who gets an infectious disease doesn't get the same disease again. (There are exceptions: many different viruses can cause the common cold, for example, and flu viruses change from year to year, so existing antibodies might not recognize them.)

This is a very efficient system. There is only one problem with it.

The first time a child is exposed to a disease, his immune system can't create antibodies quickly enough to keep him from getting sick. Eventually they will fight off the infection, and leave the child immune to future infections. But not before the child gets sick with the disease.

In other words, the child has to get sick before becoming immune.

Vaccines

This problem is solved by vaccines. Vaccines contain the same germs that cause disease (for example, measles vaccine contains measles virus, and Hib vaccine contains Hib bacteria). But they have been either killed, or weakened to the point that they don't make you sick. Some vaccines contain only a *part* of the disease germ.

When a child is vaccinated, the vaccine stimulates his immune system to produce antibodies, exactly like it would if he were exposed to the disease. The child will develop immunity to that disease, and best of all he doesn't have to get sick first.

This is what makes vaccines such powerful medicine. Unlike most medicines, which treat or cure diseases, vaccines *prevent* them.

How *Well* Do Vaccines Work?

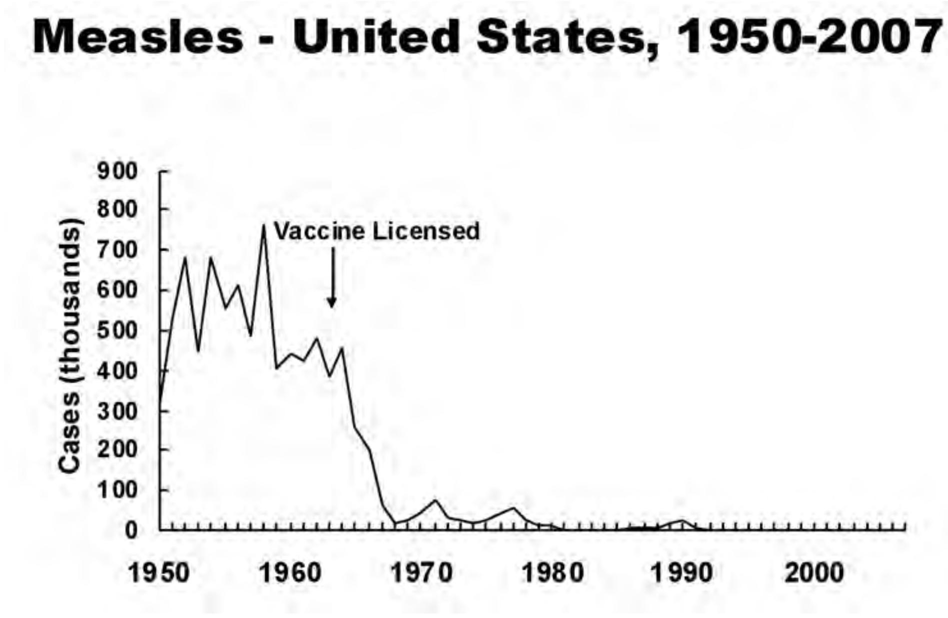
They work really well. No medicine is perfect, of course, but most childhood vaccines produce immunity about 90% - 100% of the time. (What about the small percent of children who don't develop immunity? We'll get to them later.)

But first, what about the argument made by some people that vaccines don't work that well . . . that diseases would be going away on their own because of better hygiene or sanitation, even if there were no vaccines?

That simply isn't true. Certainly better hygiene and sanitation can help prevent the spread of disease, but the germs that cause disease will still be around, and as long as they are they will continue to make people sick.

All vaccines are licensed by the Food and Drug Administration (FDA), and a vaccine must undergo extensive testing to show that it works and that it is safe before the FDA will approve it. Among these tests are *clinical trials*, which compare groups of people who get a vaccine with groups of people who don't. Unless the vaccinated groups are much less likely to get the disease, the vaccine won't be licensed.

If you look at the history of any vaccine-preventable disease, you will virtually always see that the number of cases of disease starts to drop when a vaccine is licensed. Here's a chart showing this pattern for measles:



Measles vaccine was licensed in 1962, and as you can see, that's when the number of cases started to decline. (Measles didn't completely disappear after 1993; there have just been too few cases to show up on this graph.)

If the drop in disease were due to hygiene and sanitation, you would expect all diseases to start going away at about the same time. But if you were to look at the graph for polio, for example, you would see the number of cases start to drop around 1955 – the year the first polio vaccine was licensed. If you look at the graph for Hib, the number drops around 1990, for pneumococcal disease around 2000 — corresponding to the introduction of vaccines for those diseases.

How Safe Are Vaccines?

This is a question that will naturally concern any new parent. No matter how good vaccines are at preventing disease, no matter how much they have reduced disease over the years, no matter how many lives they have saved, what if they can actually harm my baby?

Vaccine safety is a complex issue. We will address some specific safety issues in the Frequently Asked Questions section of this booklet. In the meantime, here are some general facts:

Can vaccines harm my child? Any medicine can cause a reaction, even aspirin. Vaccines are no exception.

Will vaccines harm my child? Probably not. Most children won't have any reaction at all to a given vaccine. For those who do, most reactions are very minor . . . a sore leg, a slight rash, or a mild fever that goes away within a day or two.

Some children have moderate reactions like a high fever, chills, or muscle aches.

One of the scariest of these reactions is called a *febrile seizure*. This is a seizure, or convulsion, caused by a high fever. During a febrile seizure a child might shake uncontrollably, become unresponsive, or even lose consciousness. About one child in 25 will have at least one febrile seizure during his childhood, usually between the ages of 6 months and 3 years. They often accompany ear infections or respiratory infections. When a febrile seizure is associated with a vaccine, it is because the vaccine causes a fever, which in turn triggers the seizure. While febrile seizures look serious, fortunately they almost never are. You can learn more about febrile seizures at **www.ninds.nih.gov/disorders/febrile_seizures/detail_febrile_seizures.htm**.

Rarely, a child may have a truly severe reaction, like encephalopathy (brain infection), or a severe allergic reaction. These are the scary possibilities that make some parents think that it might actually be better not to vaccinate their children. Would it?

First, severe reactions are extremely rare.

Second, it is sometimes hard to tell whether a reaction was actually caused by a vaccine. Any serious reaction that could be caused by a vaccine could also be caused by something else. There are no serious health problems caused only by vaccines. For something that affects only one child in a hundred thousand or a million, it can be very hard to isolate the cause.

> Example: Some people used to believe DTP* vaccine caused Sudden Infant Death Syndrome (SIDS), citing as evidence lists of cases of SIDS that occurred one or two days after the DTP shot. But SIDS always occurs during the same age range when millions of babies get their routine shots, so it would be remarkable if SIDS *didn't* occasionally strike right after the shot. When scientists conducted controlled studies to test this theory they found that babies recently vaccinated with DTP were no more likely to get SIDS than those who weren't vaccinated. Subsequently, precautions such as putting babies to sleep on their backs have been found to dramatically reduce the risk of SIDS. (For more information about vaccines and SIDS, see **www.cdc.gov/vaccinesafety/Concerns/sids.html**.)
>
> *DTP is an older version of DTaP.

Third, risk doesn't exist in a vacuum. You can't evaluate the risks of vaccination without also considering its benefits.

The risk from a vaccine is the chance it will cause a child serious harm. This risk is extremely small. Even a life-threatening allergic reaction can be brought under control by the trained staff in a doctor's office. For a summary of risks associated with a particular vaccine, you can read the Vaccine Information Statement for that vaccine – these can be found online at **www.cdc.gov/vaccines/pubs/vis/default.htm**.

The most obvious benefit of vaccination is, of course, protection from disease. But there is more to it than that. There are really three types of benefit to vaccination — **personal** benefits, **community** benefits, and **future** benefits. It is worth looking at each of these separately:

a) Personal benefits.

Vaccinating your child will protect him from a dozen or so potentially serious diseases.

But how likely is it that your child will actually get one of these diseases? Remember that vaccine-preventable diseases have been declining (thanks to vaccines), and that many of them are now at all-time lows. If the risk of disease is very low, isn't the benefit of vaccination also very low?

Good question. Statistically, the chance of *your* child getting a vaccine-preventable disease may be relatively low. You are making a wager.

If you choose vaccination you are betting that your child could be exposed to disease, so you accept the tiny risk of a serious vaccine reaction to protect him if that happens.

If you choose *not* to vaccinate, you are betting that your child probably *won't* be exposed to disease, or if he is, his illness won't be serious, and you are willing to accept the small risk of serious illness to avoid the small possibility of a vaccine reaction.

In our opinion, vaccinating is by far the safer bet. Even though diseases have declined, they haven't disappeared. A recent study showed that children who had not gotten DTaP vaccine were *23 times* more likely to get whooping cough than children who had. Thirty-one children died from whooping cough in 2005. That might not be many, but the number wouldn't matter if your child were one of them.

b) Community benefits.

Back on page 32 we said that a small percentage of children fail to develop immunity from vaccines. There are also children who cannot get certain vaccines for medical or other reasons, and those who are too young to be vaccinated. These children have no protection if they are exposed to someone who is infected with a communicable disease.

When most children in a community are immune, even if one child gets sick, the disease will probably not spread. That's because it will have nowhere to go – if the sick child comes in contact only with children who are immune, the disease will die out. This is called *herd immunity*.

But when fewer children in a community are immune, it is easier for a disease to spread from person to person and cause an outbreak. As this booklet was being written, Wales was experiencing a "massive" measles outbreak because of parents' failure to vaccinate their children. And outbreaks of measles, mumps, and whooping cough are occurring around the United States – often among groups of children whose parents have refused to get them vaccinated. Recently in California, a boy who contracted measles during a European vacation came back and infected 11 of his unvaccinated classmates.

Meet Riley

In most ways Riley is a typical eight-year old girl. She takes piano and gymnastics lessons, plays soccer, likes to swim, and gets into fights with her brothers.

But Riley has something most eight-year olds don't – another child's heart. She was born with a serious heart defect and had to get a transplant within days of her birth.

To Riley's immune system, her new heart doesn't belong, because it is "non-self," like a disease germ (see page 31). Her immune system would reject it if she didn't take special drugs. These drugs suppress her immune system, and because of this she can't get live-virus vaccines like measles, mumps, rubella, or chickenpox.

Consequently, Riley is not immune to these diseases. She has to depend on the immunity of people around her for protection. If one of her schoolmates or playmates were to come down with a case of measles or chicken-pox, Riley could easily catch it from them. And because her immune system can't fight off the infection, it could become very serious if not treated promptly.

Riley enjoys a normal life today, partly thanks to her friends who are protecting her from infections by getting all their shots.

Riley's self-portrait

In other words, you are not just protecting your own child by getting her vaccinated, you are protecting other children – adults too.

c) Future benefits.

Rates of vaccine-preventable diseases are very low in the United States. So the risk of an individual child getting, say, a case of measles is very low too. What would happen, then, if we all just stopped vaccinating? We know what would happen because we have seen it in other countries. Diseases that have been declining for years would come back.

> Example: In the mid-1970s, most Japanese children (about 80%) got pertussis vaccine. In 1974 there were only 393 cases of whooping cough in the entire country, and no one died from it. But then, because of a scare about the vaccine's safety, the immunization rate dropped to only about 10% over the next few years. By 1979 the country was in the grip of a whooping cough epidemic that infected more than 13,000 people and left 41 dead that year. When routine vaccination was resumed, the disease numbers dropped again.

The point is, we can't stop vaccinating, because even though disease rates are low, they are not zero. Even a few cases in a vulnerable population could touch off a major outbreak. This is why we still vaccinate against polio, even though we haven't seen it in this country for more than 10 years. One infected traveler from a country where polio *hasn't* been eliminated could set us back 50 years if our own population wasn't protected.

To summarize: When you vaccinate your child, you are not just protecting her. You are also protecting her friends and schoolmates and their families; and you are also protecting her children, her grandchildren, and all future generations.